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"METHOD TO PRODUCE POLYURETHANE ARTICLES
AND RELATIVE DEVICE"

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FIELD OF THE INVENTION

5 The present invention concerns a method to produce polyurethane articles, covered on one or more sides with one or more decorative and protective films, normally made of thermoplastic material.

10 The invention also concerns a device comprising a molding apparatus and at least a heating assembly which, in a position outside the molding apparatus and before the definitive thermoforming operation that takes place in the mold, carries out a treatment to heat and pre-form at least a segment of film in order to improve the quality of the
15 final product, increase the flexibility of the process and reduce the overall times of the cycle.

20 In the method according to the invention the steps of thermoforming the decorative film(s) and of injecting/molding the polyurethane material are preceded by at least a heating step and at least partial pre-molding of the decorative thermoplastic film.

25 The invention is applied in the field of molding articles of polyurethane material, such as small pieces of furniture, wings, panels for automatic distributing machines or electric appliances, containers, car panels, car hoods or suchlike.

BACKGROUND OF THE INVENTION

30 Various methods are known to produce polyurethane articles, which are finding ever more varied applications in many fields of use.

 An example of such methods is described in the international patent application WO-A-02/20239, in the name of the present Applicant, according to which, at least on

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one visible face of the polyurethane article, a decorative film, normally consisting of a thin film of thermoplastic material, is applied to cover and at least partly protect the article.

5 The method described in said patent application provides to position the film, outside the mold, on a plane ring-nut support, to insert said ring-nut support into the mold, to thermoform the film by means of contact with the punch of the partly closed mold, to close the mold and to
10 inject the polyurethane inside the mold.

 Although it is extremely efficacious in terms of obtaining a covered article, finished in every part, in a single step, and with a considerable automation of all the operations in the process, this method has a disadvantage
15 due to the fact that it needs a relatively long waiting time for the decorative film to be heated and thermoformed.

 Moreover, the time required to heat the film is added to the time required for thermoforming, since it is not possible to even partly superimpose these two distinct
20 operations, which are performed by the same molding apparatus.

 Furthermore, by carrying out the heating using the punch of the mold, there is a low calorie yield in the transmission of heat, since the punch cannot exceed the
25 polymerization temperature of the polyurethane. This puts a limit also on the types of materials which can be used, both of polyurethane for the article and of thermoplastics for the film. Moreover, the geometry of the punch considerably limits the efficacy of a correct and possibly diversified
30 diffusion of the temperature on the surface of the film, due to the presence of ribs or ridges on the figure.

 In the state of the art there are known solutions which provide to heat a covering film for articles made of plastic

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material before they are introduced into the mold. For example, EP-A-0.551.526 describes a method to mold a multi-layer article made of thermoplastic resin, wherein a covering sheet is pre-heated by means of a pre-heating panel. The panel can integrally incorporate a heating source or the heating source can be an element distinct from the panel.

The panel has holes, which affect the aesthetic figure, communicating with a pipe connected to a vacuum line by means of a valve, in order to retain the skin on the surface of the panel. Once the skin has been heated to the desired temperature, the panel is transferred between the elements of the mold to be rested on its lower part or its upper part. By bringing the panel into contact with a perimeter part of one element of the mold, blowing air and at the same time sucking in by means of holes made in the face of the mold, the skin is transferred from the pre-heating panel to the mold. When transfer has been completed, the panel is taken outside the mold again so that a new sheet of skin can be picked up. Then, the mold closes and the thermoplastic resin is injected into the molding cavity.

EP-A-0.101.095 describes a method and a device for injecting molded articles, at the same time forming designs on their surface.

US-A-5.800.771 teaches to apply a film bearing a decorative design on a face of a molded article; before being inserted into the mold, the film is heated outside the mold on a heating table. The film is held on the table by suction holes. Then the film is transferred to the female part of the mold by means of vacuum means. Then the elements of the mold are closed and the resin is injected into the molding cavity. The heating table has a specific holding frame and includes means to maintain the film under tension,

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preventing the formation of creases or wrinkles.

Document JP-A-62-264919 describes a process wherein a hot plane is used that has suction holes over its whole surface, in order to retain a sheet of resin on which a decorative pattern is impressed. The sheet of resin is then transferred inside a mold that is then closed and the resin is injected inside the mold to form the article.

EP-A-0.584.042 describes a method to apply a colored covering to a molded article, wherein a colored sheet is taken from a transfer plate, which possibly pre-heats it, and inserted inside a mold, to which it is transferred by means of vacuum means.

These state of the art solutions have various disadvantages in terms of operating efficiency and quality of the final product obtained. In the first place, they do not provide that, during the heating step that precedes the introduction into the mold, the thermoplastic film can be subjected to actions of partial deformation, intended to reduce the time taken for the subsequent thermoforming that takes place inside the mold. In second place, these known solutions use suction means with holes that are generally included in the part of the film that covers the figure of the article, leaving marks and imprints which lower the final quality of the article. Furthermore, the transfer of the film from the heating plane or table to the elements of the mold is not functional and not efficient, often requiring the intervention of mechanical film-presses which, apart from being complex and sometimes rather unreliable, can lower the quality of the covered article.

Applicant has studied, devised and embodied the present invention to overcome these shortcomings of the state of the art and to obtain other advantages.

SUMMARY OF THE INVENTION

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The present invention is set forth and characterized in the main claims, while the dependent claims describe other innovative characteristics of the invention.

One purpose of the invention is to achieve a method and
5 a device to produce polyurethane articles wherein, thanks to the heating of the segments of film made at least partly outside the mold, it is possible to reduce the overall times of the cycle, to increase the thermoformability and characteristics of size and quality of the decorative films
10 applied, and to completely separate the heating process from the process of polymerizing the polyurethane.

Another purpose is to achieve a device wherein the means to heat the decorative film have a high yield in transferring heat, great simplicity, both in terms of
15 construction and also in terms of maintenance and replacement of parts, and also high versatility and adaptability to various operating situations.

A further purpose is to allow the transport and positioning of the segment of film inside the press in any
20 position whatsoever, either horizontal, vertical or inclined, also using robotic gripping and handling systems.

The invention is applied in the production of polyurethane articles of the type covered on at least one side by at least a decorative film, normally consisting of a
25 thermoplastic film whose thickness can vary from a minimum of 0.2 mm to a maximum of 3 mm and more.

The device according to the invention is of the type comprising one or more molds, each one provided with at least a first part and at least a second part defining
30 between them a cavity inside which polyurethane material is introduced.

The device according to the invention also comprises a heating assembly, movable and equipped with at least a

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heating element suitable to heat at least a segment of said film in a position at least partly outside the mold, and to position the at least one heated segment of film in cooperation with said first or second part of said mold.

5 The heating assembly comprises a bearing structure for a substantially plane heating element and a specific frame which supports anchor means in order to associate the segment of film at least temporarily to the heating element.

10 The bearing structure is of the so-called universal type, that is to say, adaptable for a plurality of films of different type and size, while the specific frame is replaced every time that the type of film used is changed.

15 According to a characteristic of the invention, the specific frame is equipped with vacuum means suitable to carry out a pre-forming of the segment of film; in other words, during heating, the film is subjected to a shaping in order to form it which on the one hand facilitates and simplifies its coupling with one or the other of the elements of the mold, and on the other hand reduces the time
20 required to carry out and complete the thermoforming inside the mold.

25 The vacuum means that achieve said pre-forming, according to a preferential embodiment of the invention, are all arranged outside the portion of the segment of film that will be applied on the figure of the article. In other words, the vacuum is made to act only on the perimeter portion of the segment of film which, when it is applied on the article, is outside the figure and, when the cycle is completed, is trimmed and then eliminated.

30 In this way, on the one hand, the method guarantees an effective pre-forming, without bubbles, starting from the center of the segment of film towards its periphery, and on the other hand it prevents the formation of imprints or

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marks on the portion of film coinciding with the figure of the article.

According to a variant, there is an insulating element between the heating element and the specific frame.

5 In a first form of embodiment, specific for single-film articles made in a closed mold, the device is also provided with ring-nut means movable between a first position outside the mold and a second position at least partly superimposed on the perimeter of one part of the mold in order to
10 cooperate with the latter during the molding of said polyurethane material. In this case, the heating assembly is movable between a first position outside the mold, wherein it at least partly performs the heating and the forming of the segment of film, and a second position inside the mold,
15 wherein it positions the segment of heated film in cooperation with the ring-nut means in order to complete the forming step.

In a second form of embodiment, specific for double-film articles made in an open mold, the device according to
20 the invention has a mold with two parts, hinged together, which close like a book so as to define the molding cavity. In this embodiment, the heating assembly can assume a first position wherein it heats, pre-forms upwards and positions a first segment of film in cooperation with a part of the
25 mold, and a second position wherein it heats and positions a second segment of film in cooperation with the other part of the mold.

In a third form of embodiment, specific for single-film articles made in an open mold, the device according to the
30 invention has a mold in which the two parts are separate and free from each other, and are superimposed so as to define the molding cavity. In this embodiment the heating assembly is movable between a first position outside the mold,

wherein it performs the heating step and at least a partial pre-forming upwards of the segment of film, and a second position inside the mold, wherein it positions the heated segment of film in cooperation with one of the parts of the
5 mold.

In all the forms of embodiment, the segment of film is heated and partly thermoformed, or pre-formed, before the step of definitive thermoforming and molding which occurs inside the mold, so that, when it is coupled with one of the
10 parts of the mold, it has increased characteristics of formability and coupling to the relative inner walls.

Moreover, when the heating and pre-forming of the segment of film take place outside the mold, it is possible to perform these steps while injection is taking place, and
15 hence the polymerization of the polyurethane inside the mold, in order to produce an article covered with a segment of film already prepared and heated in the previous cycle; in this way the waiting time, which would otherwise be wasted, is used to start the heating of the film for the
20 following article, and therefore the overall time of the cycle is reduced.

The heating assembly can be of any known type and is not part of the molding apparatus; according to the invention, depending on the type of material or on the
25 thickness of the film, it is possible, with the heating assembly, to regulate the heating temperature in a desired manner so as to optimize the transfer of heat and the overall yield of the entire apparatus. According to the invention, the heating temperature can be regulated to
30 assume differentiated values in different zones of the segment of film, so as to increase the precision of the heating operation especially at the most critical forming points.

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According to a variant, the anchor means and/or the frame and/or the possible ring-nut means are equipped with means able to create a vacuum zone between the elements in reciprocal contact. In this way, the usual mechanical
5 retaining means are eliminated, which allows to reduce the bulk of the device, guaranteeing an optimum grip on the film during the entire molding cycle without risk of ruining the surface thereof.

According to another variant, the frame of the heating
10 assembly comprises means which, when the heating assembly is inside the mold, allow to release the vacuum holding the film, for example by introducing ambient air. This allows to increase the speed of thermoforming, prevents any possible cooling of the film and improves the efficacy and quality of
15 the forming itself.

According to another variant, the specific frame of the heating assembly has a perimeter profile of the anti-slip type in order to prevent movements of the segment of film during the thermoforming. In a preferential embodiment, the
20 perimeter profile comprises at least a hollow, a tooth or a combination of hollows and teeth, suitably shaped.

According to a variant, there are several molds in line, operating in sequence and having the same characteristics as the embodiments described above, in order
25 to obtain a greater productivity.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other characteristics of the present invention will be apparent from the following description of some preferential forms of embodiment, given as a non-
30 restrictive example with reference to the attached drawings wherein:

- fig. 1 shows a cross section of a first form of embodiment of part of the device to produce

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polyurethane articles, with the single-film, closed mold technique, according to the present invention in an operative forming step;

- figs. 2a to 2c show a cross section, in three distinct steps of the cycle, of a heating assembly of the device in fig. 1;
- fig. 3 shows an enlarged detail of fig. 1;
- figs. 4a to 4h show the production cycle of polyurethane articles of the device in fig. 1;
- fig. 5 shows a second form of embodiment, with the double-film technique, of part of the device according to the invention;
- figs. 6a to 6h show the production cycle of the device in fig. 5;
- fig. 7 shows a variant of a step in the cycle shown in figs. 6a to 6h;
- fig. 8 shows a third form of embodiment, with the single-film, open mold technique, of part of the device shown in fig. 1;
- figs. 9a to 9f show the production cycle of the device in fig. 8.

DETAILED DESCRIPTION OF SOME PREFERENTIAL FORMS OF EMBODIMENT OF THE INVENTION

In the figures from 1 to 4h, the reference number 10 denotes generally a first form of embodiment of a molding device according to the invention to produce polyurethane articles 37.

The device 10 comprises a molding apparatus 30 (figs. 1 and 4a) consisting in this case of a female part 13, or matrix, and a male part 12, or punch, associated with a press element 11, partly shown in fig. 4a, which can be driven to open/close by means of movement actuators which are not shown here. It comes within the field of the

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invention that the molding apparatus 30 consists of two female parts, two male parts, or other suitable configurations.

5 The male part 12, in this case in a substantially central position, has an injection channel 17, associated with an injection head 117, through which expanded polyurethane is injected, when the mold is closed, into a molding cavity 28 defined between male part 12 and female part 13.

10 It is obvious that, within the field of the invention, the injection channel 17 could be located in a non-central position, or there could be two or more injection channels, possibly used alternately.

In this case, the molding device 10 comprises reel means 20 able to feed a thermoformable covering film 19 which is then inserted into the mold 30 and made to adhere by thermoforming, as will be explained in more detail later, so as to cover the inner wall of the female part 13.

The film 19 is made of thermoplastic.

20 The device 10 also comprises a heating assembly 15 movable between a first position outside the mold 30 and a second position, wherein it is taken into association with the female part 13 of the mold 30. The function of the heating assembly 15 is to heat and pre-form the segment of film 19 outside the mold 30, and to then transport said segment of film 19 inside the mold 30, in order to complete the thermoforming and discharge the segment of film 19 onto the female part 13, or possibly on the male part, of the mold 30.

30 In the specific embodiment shown here, and as can be seen in greater detail in fig. 1, the device 10 also comprises an annular ring-nut 22, of the movable type, having a front perimeter edge 23 which, when the ring-nut 22

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is coupled with the female part 13 of the mold 30, is facing towards the molding cavity 28. The front edge 23 is suitable to perform a function of continuity substantially in correspondence with the separation zone which forms, when
5 the mold is closed, between the female part 13 and the male part 12 of the mold.

In this way, the article 37 can be discharged from the mold 30 substantially already finished, and only requires perimeter trimming of any possible excess film 19.

10 The annular ring-nut 22 is moved in coordination, or not, with the heating assembly 15, to insert and form the film 19 in the mold 30 and then to discharge the finished polyurethane article 37 from the mold 30.

The cycle to move the heating assembly 15 and the ring-nut 22, in order to mold a polyurethane article 37, is shown
15 in figs. 4a to 4h.

The device 10 also comprises discharge means 35 able to discharge the finished article 37 from the ring-nut 22, and means 36 arranged downstream of the reel 20, to unwind and
20 cut the film 19, and able to position a segment of film 19 on a supporting plane 31.

The heating assembly 15 (figs. 2a-2c) substantially comprises a bearing structure 16, of a substantially universal type, on which are assembled a heating element 39,
25 an insulating element 40 and a specific frame 41 for gripping and pre-forming the film 19; by specific frame we mean an element that can be replaced so as to adapt to the specific sizes, forms and characteristics of the film to be thermoformed.

30 The bearing structure 16 is advantageously formed by metal sheets which facilitate a rapid dissipation and transfer of the heat produced by the heating element 39, and allow to couple the heating assembly 15 to movement means,

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such as for example a mechanical arm, a linear guide or otherwise, of a known type and not shown in the drawings. In this way, and thanks to its characteristics of gripping and holding the film, the heating assembly 15 can easily be
5 displaced and transferred from a zone wherein the segment of film is prepared, to the delivery zone inside the mold in any direction whatsoever. In fact, the movement means can also be of the robotic type and allow to transport and handle the heating assembly 15, with the segment of film 19,
10 in any position and with any spatial orientation, for example horizontal, vertical or inclined.

The movement means displace the heating assembly 15 from its first position outside the mold 30 to its second position inside the mold 30, and vice versa, in the way
15 described hereafter.

The heating element 39, in this case and only to give an example, consists of a foil-type electric resistance, advantageously having different zones which can be regulated individually within a range of temperatures which can even
20 reach values which can reach up to 220-250°C and more. The presence of such independent regulation zones allows a differentiated heating of the corresponding zones of the film 19 according to the specific piece to be covered and to the shape of the mold 30.

25 According to a variant, the heating element 39 is formed by a metal plate, advantageously made of aluminum, provided with a hydraulic circuit for water, or for diathermal oils. The insulating element 40 is located between the bearing structure 16 and the heating element 39,
30 so that the latter does not overheat the bearing structure 16 excessively, and to increase the quantity of heat transmitted to the film 19 to be heated.

The specific frame 41 is associated on its perimeter

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with the lower part of the heating element 39 and is provided with an anchor device 21 to at least temporarily anchor the film 19 to the specific frame 41. The anchor device 21 holds the perimeter part of the film 19 adherent
5 to the specific frame 41 (fig. 3) by means of first vacuum means comprising a pipe 43.

Second vacuum means, comprising a pipe 45, are selectively activated to pre-form upwards the segment of film 19, to guarantee constant contact of the whole surface
10 with the heating element 39. This guarantees a uniform and complete heating of the film 19, without the formation of cold points and without any temperature gradients being generated. This is particularly important in the case of very thin films, for example with thicknesses in the range
15 of 0.2-1 mm. The upward pre-forming also allows to possibly carry out thermoforming on the punch 12 instead of on the matrix 13. Another derived advantage is that, when the film 19 is inserted already pre-formed into the mold, the time needed to complete the thermoforming is considerably
20 reduced.

The second pre-forming pipe 45 is arranged outside the portion of film 19 that will couple, in the mold, with the figure of the article. In this way, we prevent the formation of imprints or marks in the part which has the aesthetic
25 finishing. Moreover, the peripheral suction guarantees a uniform pre-forming from the center towards the periphery.

The pipe 45 has an extension 45a (figs. 2a, 2b) in communication with the empty space 50 between the film 19 and the heating element 39. Once the film 19 has been picked
30 up, and while it is being transported towards the mold 30, the pipe 45 is activated to create a depression in said space 50 so that the film 19 progressively pre-forms upwards; thanks to the peripheral position of the pipe 45,

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the pre-forming occurs progressively, starting from the center (figs. 2a, 2b) until it affects the whole peripheral zone of the film 19. At the end of the pre-forming operation, the film 19 to be inserted into the mold 30 is
5 totally adherent to the heating element 39, thus allowing to reduce the time required to complete the thermoforming inside the mold 30.

Then, when the frame 41, inside the mold 30, rests on the ring-nut 22 to transfer the film 19, third vacuum means
10 47 on the ring-nut 22 are activated. According to a variant, the third vacuum means 47 are not present, but the film 19 is transferred by activating in an appropriate manner the first 43 and/or second 45 vacuum means, and/or the vacuum means associated with the elements of the mold.

15 In the subsequent step, before the film 19 is thermoformed, fourth vacuum means present on the frame 41 are finally activated; these comprise a conduit 48 and a chamber 49 which, by making the frame 41 adhere closely to the ring-nut 22, ensure that the film 19 is gripped on the
20 perimeter; in this way the need to use complex and burdensome retaining elements of a mechanical type is avoided, and an efficacious treatment is guaranteed without the risk of ruining the film 19. In this case too, according to a variant, the vacuum means 48, 49 can be replaced by
25 vacuum means present on the mold.

It should be noted that the first 43, third 47 and fourth 48 and 49 vacuum means are all arranged and act only outside the aesthetic part of the film 11 which will couple with the figure of the article, for the reasons identified
30 above.

Once the film 19 has been firmly gripped on the perimeter, thermoforming is then carried out, by activating in a conventional manner the vacuum means present on the

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female part 13 of the mold 30, to make the film 19 adhere to the walls of the female part 13.

According to a variant which is not shown here, on the frame 41 there are means which can be selectively activated to release the vacuum between the film 19 and the heated plane, for example by making ambient air enter between the film 19 and the heating element 39; this allows to increase the speed of thermoforming and to reduce the possibility that the film 19 might cool down due to its prolonged contact with the inner walls of the female part 13.

It comes within the field of the present invention that single vacuum means, or a combination of two or more thereof, allow both to hold the perimeter part of the film 19 adherent to the specific frame 41 outside the mold 30, and also to pre-form upwards the segment of film 19, and also to transfer the film 19 from the frame 41 to the ring-nut 22, and also to make the frame 41 adhere closely to the ring-nut 22, and also to ensure the film 19 is gripped on the perimeter, and also to carry out the forming operation.

The cycle relating to the solution as described heretofore is as follows.

In fig. 4a, the ring-nut 22 and the heating assembly 15 are in a position outside the mold 30 and in proximity with the reel 20 which feeds the film 19. The heating assembly 15 is above the supporting plane 31. After a segment of film 19 of the desired size has been unwound, cut and arranged above the supporting plane 31, the anchor device 21 of the specific frame 41 is activated, in order to hold the film 19 in cooperation with the heating element 39, thanks to the first vacuum means 43.

By activating the second vacuum means 45, the film 19 deforms partly upwards, as can be seen in fig. 4b, pre-forming and increasing the surface of contact with the

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heating element 39, and possibly heats in a differentiated manner on the surface according to the regulations set by the heating element 39.

5 The heating assembly 15 and the ring-nut 22 are then translated simultaneously along a substantially horizontal plane (fig. 4b) to be taken to a position inside the mold 30, in an intermediate position between the female part 13 and the male part 12.

10 Subsequently (fig. 4c), the ring-nut 22 is lowered substantially to rest on and couple with the perimeter of the female part 13, or possibly of the male part 12, while the heating assembly 15 is in turn lowered so as to deposit the heated film 19 onto the ring-nut 22. The film 19 is transferred from the heating assembly 15 to the ring-nut 22
15 and held thereon by the possible third vacuum means 47.

During the transfer of the first segment of film 19 inside the mold 30, the unwinding and cutting means 36 can prepare a second segment of film 19 on the supporting plane 31. Then the anchor device 21 is de-activated and, since it
20 is already heated and pre-formed, the film 19 is thermoformed in a relatively short time and made to adhere to the inner wall of the female part 13.

Before the thermoforming operation, the fourth vacuum means 48, 49 are activated, with the function of pressing
25 the film on the perimeter. According to a variant that is not shown here, as we have said, the fourth vacuum means 48, 49 are not present and the function of pressing the film on the perimeter is performed by vacuum means present in the elements 13 or 12 of the mold 30. After the thermoforming
30 operation, the heating assembly 15 is taken outside the mold 30 (fig. 4d).

The subsequent step (fig. 4e) simultaneously provides, in the mold 30, to lower the male part 12 until the molding

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cavity 28 is defined with the female part 13 and, outside the mold 30, to associate a new segment of film 19 with the heating assembly 15. During this step, in the mold 30, the polyurethane material is also injected, in foam form, by means of the head 117 and the injection channel 17 inside the cavity 28 and, outside the mold 30, the step of heating the new segment of film 19 begins.

In this way, on the one hand the time required to thermoform the film 19 is reduced thanks to the pre-forming performed outside the mold 30, and on the other hand the time required for the polymerization of the polyurethane is used to heat the segment of film 19 to be used in the subsequent molding cycle, which leads to a considerable reduction in the overall times of the cycle.

The heat and pressure generated during the polymerization of the polyurethane complete the thermoforming of the film 19 and the definitive and stable fixture thereof to the outer surface of the article 37 being formed.

When the molding operation is finished, the mold 30 is opened (fig. 4f) and the annular ring-nut 22 is first raised, then translated laterally to its initial position, to allow the article 37 made to be extracted and removed by means of the discharge means 35 (fig. 4g). The article 37 remains resting on the ring-nut 22 due to the presence of the perimeter edge of the excess film 19. At the same time, the heating assembly 15 continues to heat and pre-form the new segment of film 19 which it will position in correspondence with the female part 13 so as to start a new production cycle.

The article 37 is sent from the discharge means 35 to a trimming station to trim the perimeter of the film 19, so as to complete the process and obtain the finished piece.

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At this point (fig. 4h), we return to the condition shown in fig. 4a, thus starting a new production cycle for the next article, which cycle will be considerably shortened thanks to the fact that the film 19 is already in an optimum
5 heated state.

In figs. 5 to 7, the reference number 110 denotes generally a second form of embodiment of the device according to the present invention.

The device 110 comprises a molding apparatus 130
10 consisting of a female part 113, or matrix, and a male part 112, or punch, hinged together in this case at one end and able to be selectively opened/closed by means of movement actuators which are not shown here. The mold 130 is used for the production of polyurethane articles 137 covered on both
15 sides by the film 19. This type of mold 130, as will be explained in more detail later, allows to position a relative segment of film 19 both on the female part 113 and also on the male part 112. The polyurethane is injected by means of an injection head 117, which in this case is
20 autonomous with respect to the mold 130.

The device 110 also comprises the heating assembly 15, movable in this case between a loading position outside the mold 130 and a position of cooperation with the female part 113 and/or the male part 112.

25 This embodiment of the invention does not provide the ring-nut 22, and the front edge 23 is made directly inside the respective female part 113 or male part 112.

In this case, the production cycle occurs in the following way.

30 In fig. 6a, the mold 130 has the two parts, male part 112 and female part 113, in the open position, and the heating assembly 15 is in the loading position outside the mold 130 and near the reel which feeds the film 19.

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As in the first embodiment, the film 19 is deposited above the supporting plane 31, and a segment of film 19 is determined and then cut, according to the size of the article 137 to be made.

5 The segment of film 19 is anchored to the specific frame 41 of the heating assembly 15, heated to a desired temperature and pre-formed upwards.

10 The heating assembly 15 is then translated (fig. 6b) to be taken to the position wherein it cooperates with the female part 113 of the mold 130, and positions on said female part 113 the anchored and thermoformed film 19.

15 Subsequently, the heating assembly 15 is taken to the loading position (fig. 6c) to load a second segment of film 19, which has to be heated, pre-formed and positioned in correspondence with the male part 112, as happened for the first segment of film 19 positioned on the female part 113 (fig. 6d).

20 Once the second segment of film 19 has been positioned, the heating assembly 15 is taken outside the bulk of the mold 130 (fig. 6e) to the loading position and, at the same time, the polyurethane is cast by means of the injection head 117.

25 The next step (fig. 6f) provides to simultaneously close the male part 112 onto the female part 113, to associate a new segment of film 19 with the specific frame 41 of the heating assembly 15 and to begin the heating step of said new segment of film 19.

30 When the molding operation has finished, the mold 130 is opened (fig. 6g) and, by means of extractor means not shown in the drawings, the article 137 made is extracted. At the same time the heating assembly 15 has heated and pre-formed upwards the new segment of film 19 (fig. 6h) which it will then position in correspondence with the female part

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113, as in step 5b, so as to start a new production cycle.

According to the variant shown in fig. 7, two heating assemblies 15 are provided able to heat and pre-form upwards two respective films 19, and then transfer them, one into
5 the male part 112 of the mold 130 and the other into the female part 113, so as to further reduce the dead times of the production cycle and consequently the costs. In figs. 8 to 9f, the reference number 210 denotes generally a third form of embodiment of the device according to the present
10 invention.

The device 210 differs from the device 110 as previously described in the conformation of the mold 230 and due to the fact that the article 237 produced is of the single-film type. The mold 230 comprises a female part 213
15 or matrix, and a male part 212, or punch, free from each other and able to be selectively opened/closed by means of movement actuators which are not shown here. The polyurethane is injected by means of the injection head 217, which in this case too is autonomous with respect to the
20 mold 230.

The heating assembly 15 is also movable between the same positions as described for the previous embodiment, with the single difference that the film 19 is transferred only into the female part 213 of the mold 230.

25 Consequently the production cycle of this embodiment, as shown in figs. 9a-9f, differs from the one described previously for the device 110 only in that no step of positioning the heated and pre-formed film 19 into the male part 212 is performed.

30 The mold 230 can also be suitable for the simultaneous achievement of two or more adjacent figures, and will in turn provide auxiliary shearing means to separate the film 19 in correspondence with an intermediate position of said

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two figures.

It also comes within the field of the invention to provide that a single press comprises, apart from two or more figures, also two or more molds activated
5 simultaneously.

It is clear that modifications or additions may be made to the device 10, 110, 210 as described heretofore, without departing from the field and scope of the present invention.

It is also clear that, although the present invention
10 has been described with reference to specific examples, a person of skill shall certainly be able to achieve many other equivalent forms of device and method to produce polyurethane articles, all of which shall come within the field of protection of the present invention.